

Name: \_\_\_\_\_ Pledge (sign): \_\_\_\_\_

## Env Studies 201 Test #3

**Point Total:** 100 pts possible

- 6 pts 1. What are CFCs and how does their emission impact the environment? *Be complete.*  
 CFC are *chlorofluorocarbons*, small molecules containing chlorine, fluorine and carbon atoms; they were used primarily as refrigerants. Their emission contributes to stratospheric ozone depletion and global warming (since they are greenhouse gases).
- 6 pts 2. (a) Who were the stakeholders in the Love Canal incident? List them along with their primary goals.
- Hooker chemical company created the toxic waste site. Their goal was to reduce (ideally eliminate) how much they would have to pay for cleanup of the site.
  - Niagara Falls Board of Education bought the land over the waste site from Hooker and built a school on it. They also wanted to limit their exposure to liability.
  - The New York Department of Health are responsible for managing risks to the health of the residents of the state.
  - The residents of Love Canal wished to be evacuated and reimbursed for their homes.
  - The Environmental Protection Agency was involved in evaluating the risk due to exposure of the residents to the hazardous chemicals.
  - Political leaders, including the NY state governor and the President of the US.
- 6 pts (b) Was the *precautionary principle* used in the Love Canal incident? Justify your answer; include a definition of the precautionary principle.  
 The Precautionary Principle (PP) is a principle of risk management. It states that actions will be taken to reduce risk even in the absence of complete scientific certainty if the risk is potentially grave enough. It essentially lowers the burden of scientific "proof" that is required before action is taken.  
 Though some might argue that the wait was too long for the outer ring residents, eventually the PP was indeed used in the Love Canal incident: all of the residents were evacuated even before it was known with complete scientific certainty that there was a substantial health risk due to exposure of the residents to the toxic chemicals.
- 6 pts 3. How can one determine—empirically, after the fact—if an environmental treaty has been successful?  
 Basically, the question is, did the treaty affect behavior in a way that improved environmental quality and increases human welfare thereby? The trick is to try to predict what would have happened if the treaty had never been created. Data can be used to answer the following important questions:
- What was the degree of participation in the treaty? An effective treaty will bring users of the CPR to the table and get them to agree to binding limits of usage of the CPR. One can measure this by determining the fraction of stakeholder countries who signed and ratified the treaty.
  - Did signatories change their behavior as a result of the treaty in a way that improved environmental quality? An obvious way to measure this is to determine the degree of compliance among participants, but this can be misleading (compliance doesn't mean that behavior was altered compared to what it would have been without the treaty; noncompliance can still possibly result in better behavior than would have been the case in the absence of a treaty). Another way to answer this question empirically is to compare the behavior of participants to that of non-participants. One can also compare the behavior of participants before and after the treaty entered into force.
  - Did the environmental situation that the treaty was meant to address, improve in a meaningful way and to the degree that was intended by the treaty? This is determined by monitoring the state of the CPR (eg, pollution levels) before and after the treaty enters into force.

9 pts 4. What are the main criticisms of CERCLA? How do its supporters respond to these criticisms?

The main criticisms of CERCLA, and typical responses to them, are:

- *The liability scheme is unfair.* A PRP may be liable for the entire cleanup even if it is only responsible for a portion of the contamination. The standard needed to be identified as a PRP is also set pretty low, and may include a lot of small businesses. In addition, insurance companies complain that they are forced to pay for policies long thought defunct.

Supporters of CERCLA say that this provision increases the likelihood that those responsible will end up paying the bulk of the cleanup cost: if the EPA goes after the PRP with the deepest pockets, that PRP (or its insurance company) has all the incentive to turn around and sue the other PRPs and find a more equitable arrangement. And the PRPs often have access to non-public information about the nature and extent of the contamination. Finally, the high evidentiary burden faced by PRPs has been widely viewed as an effective deterrent for future improper waste disposal, making compliance with RCRA more likely.

- *The cleanup goals are too strict.* The EPA has some discretion as to what standards the contaminated site should eventually meet, and critics argue that they do not often include the most probable future use of the site. For example, the EPA may assume residential use (and demand groundwater standards based on the Safe Drinking Water Act) even if that is unlikely to happen.

Supporters of CERCLA feel that it is not possible to accurately predict future land use, and that if a site is known to be contaminated, it is disingenuous to say that it is not likely to be used for residential purposes. If the site were cleaned up to high health standards, residential use is more likely. Plus, some feel that a site should be returned, as much as possible, to conditions that existed prior to the contamination.

- *The EPA does not rank NPL sites well.* In particular, a common criticism is that the EPA does not consider the size of the population exposed to the pollution. For example, an NPL site in a rural area should have a lower priority than a site that affects a larger human population, all other things equal.

Supporters respond that this attitude smacks too much of utilitarianism, where the aggregate good is paramount, and doesn't consider a citizen's right to a healthy environment. In other words, they object to a 'majority rules' ethic.

- *Cleanup is too costly.* Critics cost that cleanup is too costly, both because of high transaction costs (eg in legal fees; see first criticism above) and high cleanup standards. In addition, the EPA often insists on using outmoded (and cost-inefficient) methods of cleanup.

Supporters argue that transaction costs are not too high compared to other cases in litigation, and that those costs are lowered because much of it is borne more by the PRPs and their insurance companies when they sue each other. And these supporters aren't too concerned about those costs (the parties could always choose not to sue, or to use less-costly mediation). Admittedly, cleanup technology used by the EPA is not always cutting-edge, but the EPA also allows the PRPs themselves to clean up sites: EPA sets the standards but allows the PRPs to achieve those standards however they choose. This results in cost-savings in both the cleanup costs (about 20%) and government legal fees.

- *Cleanup takes too long,* for reasons previously specified: litigation and high cleanup standards. Supporters counter that both liability scheme and standards are appropriate, and the most of the cleanup time is due to the complex and difficult nature of the cleanup process itself (groundwater contamination is notoriously difficult to remediate). One shouldn't expect a rapid solution to such a problem.

- 9 pts 5. Agriculture degrades air and water quality through pollution in many ways. List the pollutants—as many as you can—that agricultural activity releases into the air/water/soil. For each pollutant, briefly describe (1 sentence) the way in which it degrades the environment.
- Pesticides that kill nontarget organisms and threaten human health by polluting food and groundwater.
  - Nutrient pollution from fertilizers: nitrogen (as nitrates and ammonium salts) and phosphorus (as phosphates) cause eutrophication. Nitrate contamination of groundwater is widespread and also is directly toxic. Nitrous oxide production due to nitrification and denitrification also increases; nitrous oxide depletes ozone and is a greenhouse gas.
  - Livestock waste can contaminate surface waters, introducing pathogens, stimulating eutrophication, and directly depleting oxygen levels.
  - Crop residues also deplete oxygen levels (increase BOD).
  - Methane from livestock: methane is a strong greenhouse gas and also contributes to ozone depletion.
  - Ammonia is released into the air from livestock operations, increasing PM.
  - Fossil fuels used in agricultural operations release the usual pollutants: NO<sub>x</sub>, VOCs, CO, CO<sub>2</sub>; these cause smog, PM, acid deposition, directly threaten human health, and contribute to global climate change.
- 5 pts 6. (a) List the five main greenhouse gases present naturally in the environment.
- (1) water, H<sub>2</sub>O
  - (2) carbon dioxide, CO<sub>2</sub>
  - (3) nitrous oxide, N<sub>2</sub>O
  - (4) methane, CH<sub>4</sub>
  - (5) ozone, O<sub>3</sub>
- 6 pts (b) What is *positive radiative forcing*?
- Positive radiative forcing is when the earth is absorbing solar energy at a rate faster than it is losing energy (as infrared radiation) into space. Positive forcing is predicted to lead to eventual global warming.
- 6 pts (c) The IPCC predicts a number of likely consequences of positive radiative forcing over the next century. Briefly list/describe these predictions, being quantitative when possible.
- Global average temperatures will rise 1.8–4.0 °C by 2100.
  - Sea levels will rise 0.18–0.59 m due to thermal expansion; this could be much larger (7 m) if landlocked ice sheets melt.
  - Precipitation patterns will change; some areas will become wetting, some drier.
  - Increase in frequency and intensity of extreme climate events (eg, heavy storms, hurricanes, heat waves)
  - Will affect ecosystems and cause an increase in the spread of infectious disease
  - The Atlantic Ocean meridional overturning circulation (MOC) will slow, affecting global heat distribution and causing some regional heating/cooling.
7. Air quality standards have been established for six air pollutants (also called the *Criteria Pollutants*).
- 6 pts (a) List these six pollutants; circle the ones that are *secondary* pollutants (ie, that are not emitted directly into the atmosphere).
- Sulfur dioxide (SO<sub>2</sub>), ozone (O<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide, lead, particulate matter (specifically, PM-10 and PM-2.5). Ozone is a secondary pollutant; PM is both a primary and secondary pollutant.

9 pts (b) What are these air quality standards called? Describe in some detail how they are established using the principles of risk assessment; use the back of this sheet if necessary.

They are the National Ambient Air Quality Standards (NAAQS). They are health-based standards, meaning that the EPA sets the NAAQS levels to protect human health (there are also secondary NAAQS to protect human welfare), ignoring cost and other considerations. The principle method of determining these levels is to estimate the *dose-response curve* for the effects of pollutant exposure.

There are two classes of toxic pollutants: those that exhibit a dose-threshold, and those that do not. By 'threshold,' what is meant is that there appears to be a dosage below which there are no health effects; this is the No Observed Adverse Effect Level (NOAEL) of the pollutant. The EPA will set the NAAQS at the NOAEL, often with a margin of safety (eg, to protect sensitive populations). For pollutants that do not appear to exhibit threshold behavior (ie, the NOAEL is effectively zero), the NAAQS is set to reduce the risk from pollutant exposure to an 'acceptable level.' The acceptable level is considered a  $10^{-4}$  chance of mortality, although again often safety factors will be used to reduce this factor another 10-100-fold.

The dose-response curve is estimated through three main methods:

- exposure of animals to increasing levels of pollutant under controlled conditions; the NOAEL or acceptable-risk dosage level is determined by extrapolation from much higher dosage levels.
- clinical trials in which volunteer humans are exposed to low (nonlethal) levels of pollutants. The NOAEL or acceptable-risk level is determined by extrapolation from these low dosage levels.
- epidemiological studies: statistical correlations between exposure levels and health effects in human populations that have been accidentally exposed to pollution.

8. Two distinct modes of pollution regulation are *command-and-control* (CAC) and *incentive-based* regulation

9 pts (a) In some detail, explain CAC regulation. In your answer, be sure to state the three basic forms of CAC regulation.

9 pts (b) In some detail, explain incentive-based regulation. In your answer, state the two basic types of incentive-based regulation.

- 8 pts (c) Incentive-based methods can also be used to manage non-pollution common-pool resources (CPR). On the back of this sheet, describe in a little detail how this philosophy of regulation might be used to sustainably manage a fishery.